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Abstract: Linewidths of home build external cavity diode lasers

This research focuses on the examination of external cavity diode lasers' stability by demonstrating optical beat notes through optical heterodyne experiments

The main goal of our optical heterodyne experiments is to examine the stability of our own in house-built external cavity diode lasers (ECDL) under different locking methods. In any laser system, it is of a great use to be able to identify and remove noise sources and narrow the linewidth. That results in a greater stability of the wavelengths of the ECDL, which can successfully be used for spectroscopy, laser cooling of atoms and optical communications.

Our in-house-built ECDLs are controlled by electronic and optical means with linewidths varying between kHz-10MHz. They include a diode laser which is coupled to an external cavity that gives frequency-selective optical feedback to the diode laser through its antireflection coated facet. This concept of frequency selective feedback allows the laser to achieve narrow linewidth and tunability.

The wavelength is controlled by temperature, diode current and mechanical feedback. The wavelength of the output is mainly determined but has small variations due to different factors directly affecting it. Some of the main factors include the internal diode noise, the stability of the mechanical noise and the method of the feedback control.

In optical heterodyne measurements, the two ECDL send beams of around 780nm wavelength each and the beams are mixed to produce a beat-note with a frequency in the radio frequency(rf) range by which measurements of the frequency noise-spectrum can be taken.

Experimentally, the two single frequency output beams from the two ECDL are aligned so that they meet and interact with each other at a non-polarizing beam splitter cube(NPBS) and then emerge into a photodetector. The beat signal is then amplified and goes directly into the rf spectrum analyzer and to an oscilloscope. Data is taken in experiments that follow the same procedure but each of them includes different adjustments that can potentially minimize the noise of the frequency.

The rf beat of the two lasers is measured with an rf spectrum analyzer. The spectrum is analyzed by taking accurate measurements of the line width of the spectra, which is directly related to the noise of the laser itself. Based on that relation we can identify the locking methods that can produce the smallest linewidths of those spectrums.

The noise of the lasers is examined for several locking schemes including side lock, peak lock, which are both related to how the feedback of it is generated, and mechanical lock and current control, which are the actual control parameters of the laser itself.